Experience with MicroMegas chambers with resistive strips

Givi Sekhniaidze
INFN sezione di Napoli

On behalf of the ATLAS MicroMegas community (MAMMA)

Overview

Tests of the resistive chambers in different gas mixtures and different conditions

- Structure of chamber with resistive strips

- Laboratory tests
  - ✓ ^{55}Fe source
  - ✓ X-ray gun
  - ✓ Spark shape and characteristics

- Neutron beam tests at Demokritos laboratory in Athens:
  - ✓ Neutron beam spectra
  - ✓ V-I characteristics under neutron beam
  - ✓ Spark probability

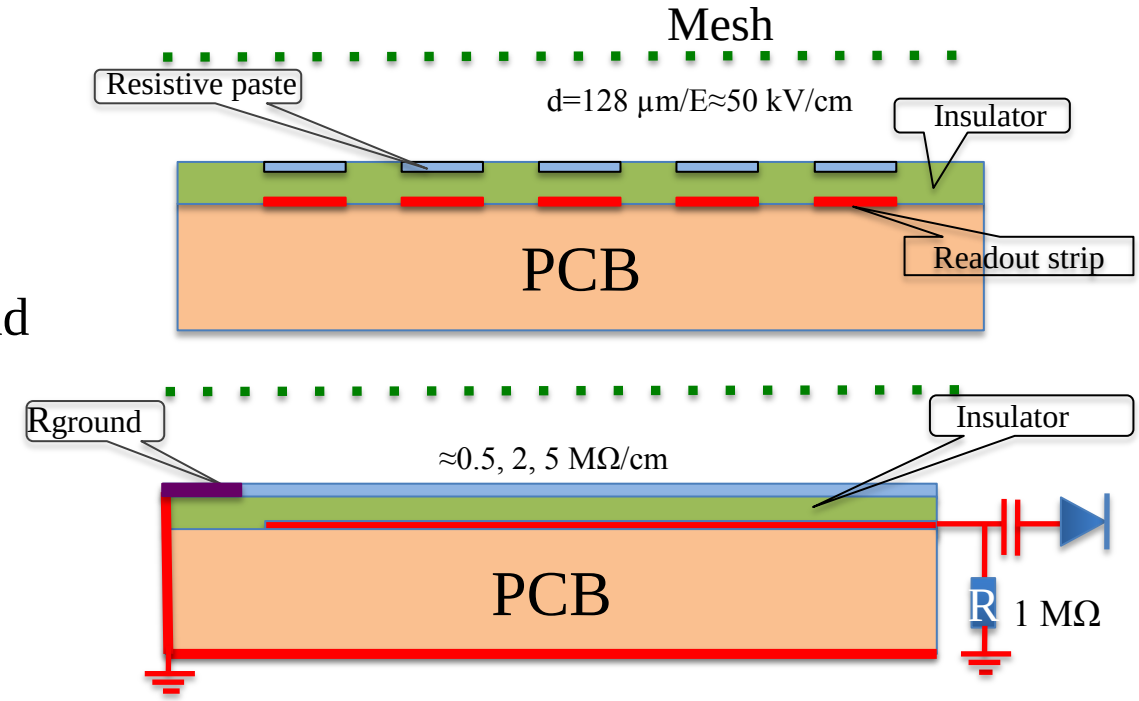
- Beam tests at H6:
  - ✓ V-I characteristics
  - ✓ Spark probability

R11, R12 and R13 (1)

- Small 100 x 100 mm^2 chamber with 100 mm long strips and 250 µm strip pitch (similar to the previous prototypes – S3, R9, R10), 360 strips in total

Characteristics:

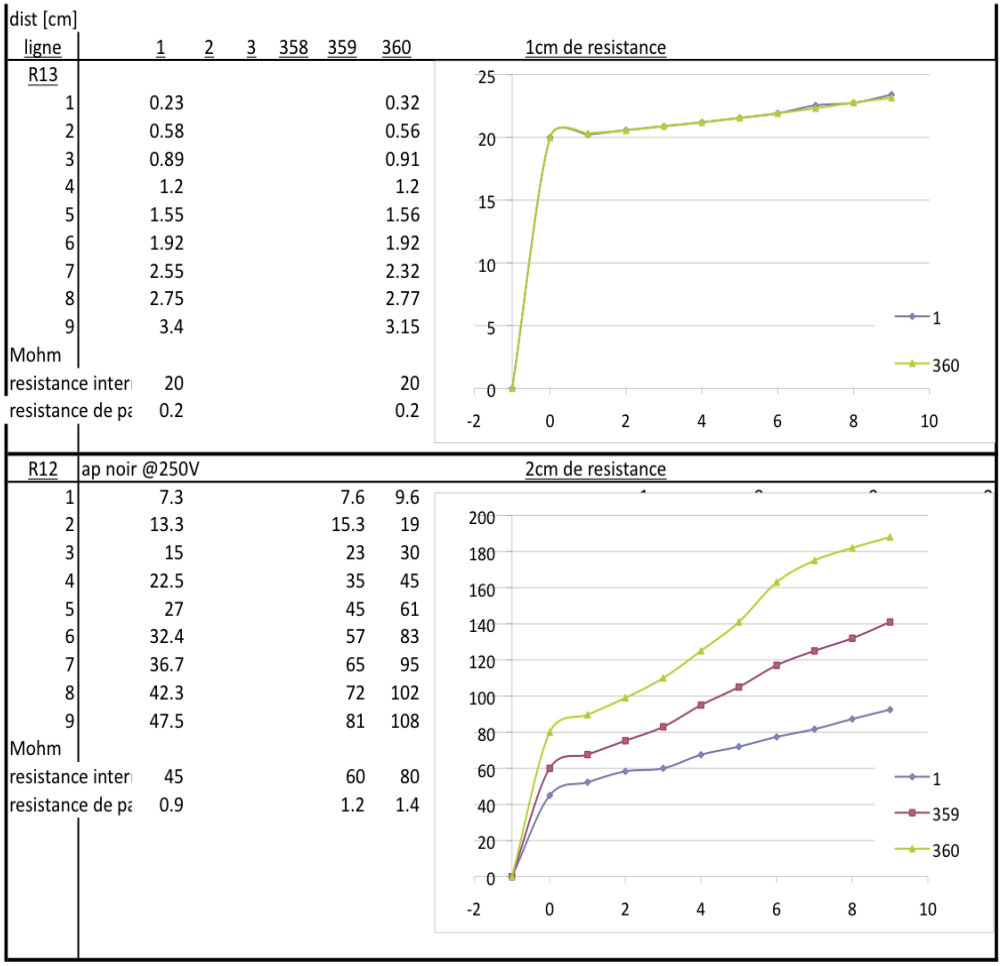
- Resistive strips connected to the ground
- Thin insulating layer between of the resistive and readout strips
- AC coupling of signals
- Sparks are neutralized through the resistive strips to the ground



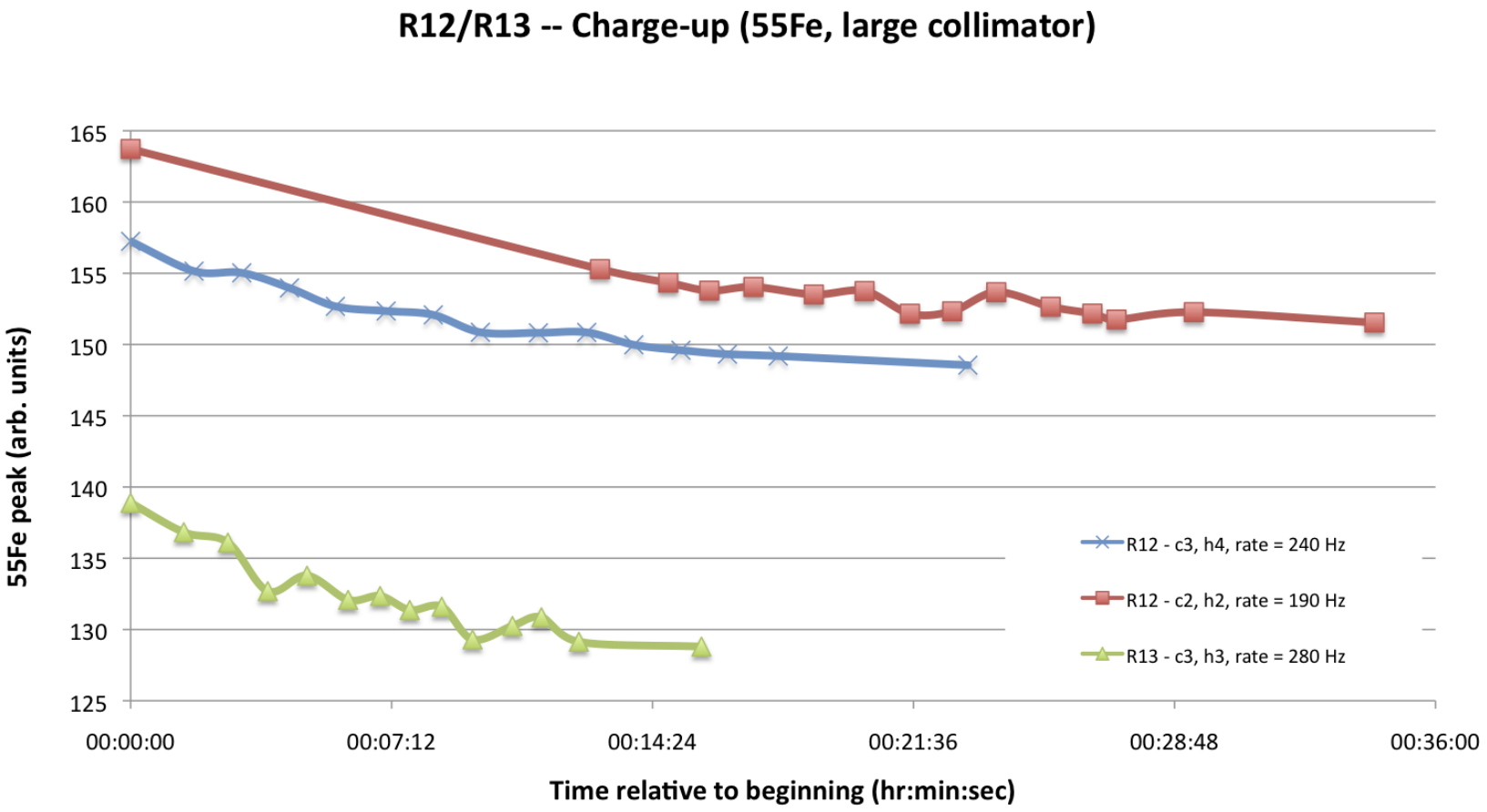
R11, R12 and R13 (2)

Resistive characteristics of the chambers

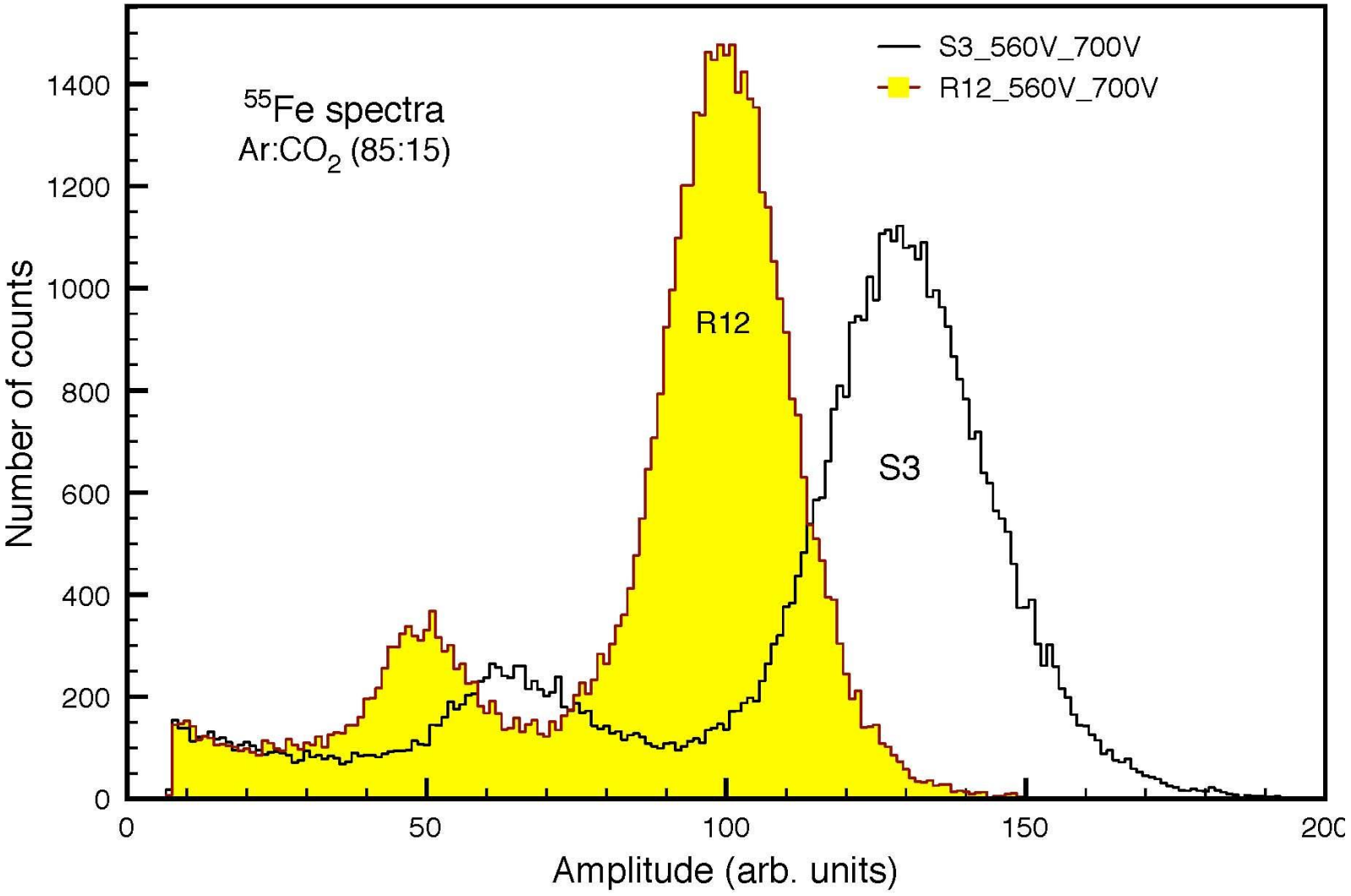
CHAMBER	R11	R12	R13
Resistance to Ground (MΩ)	15	45	20
Resistance along strip (MΩ/cm)	2	5	0.5



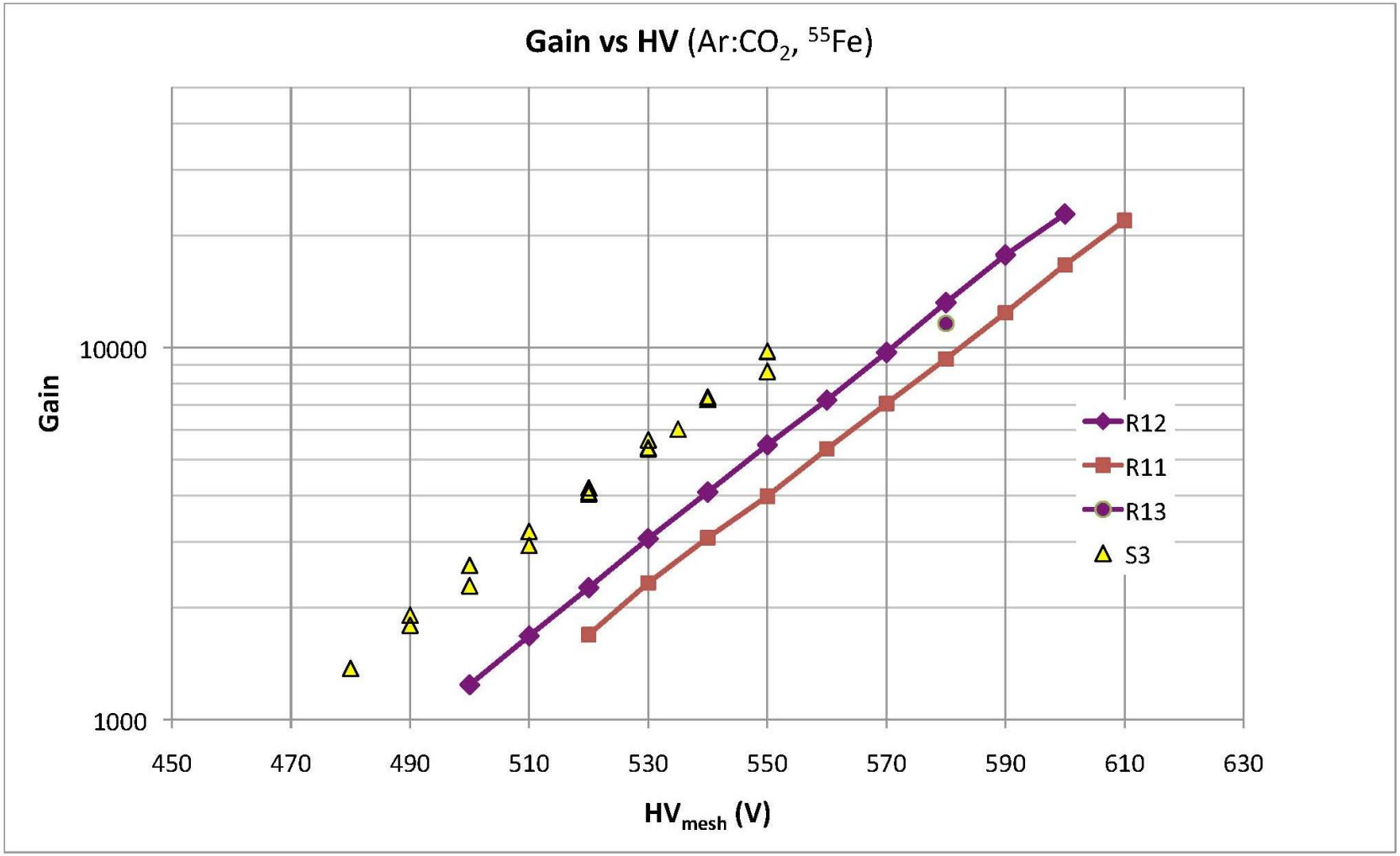
Laboratory tests (1)



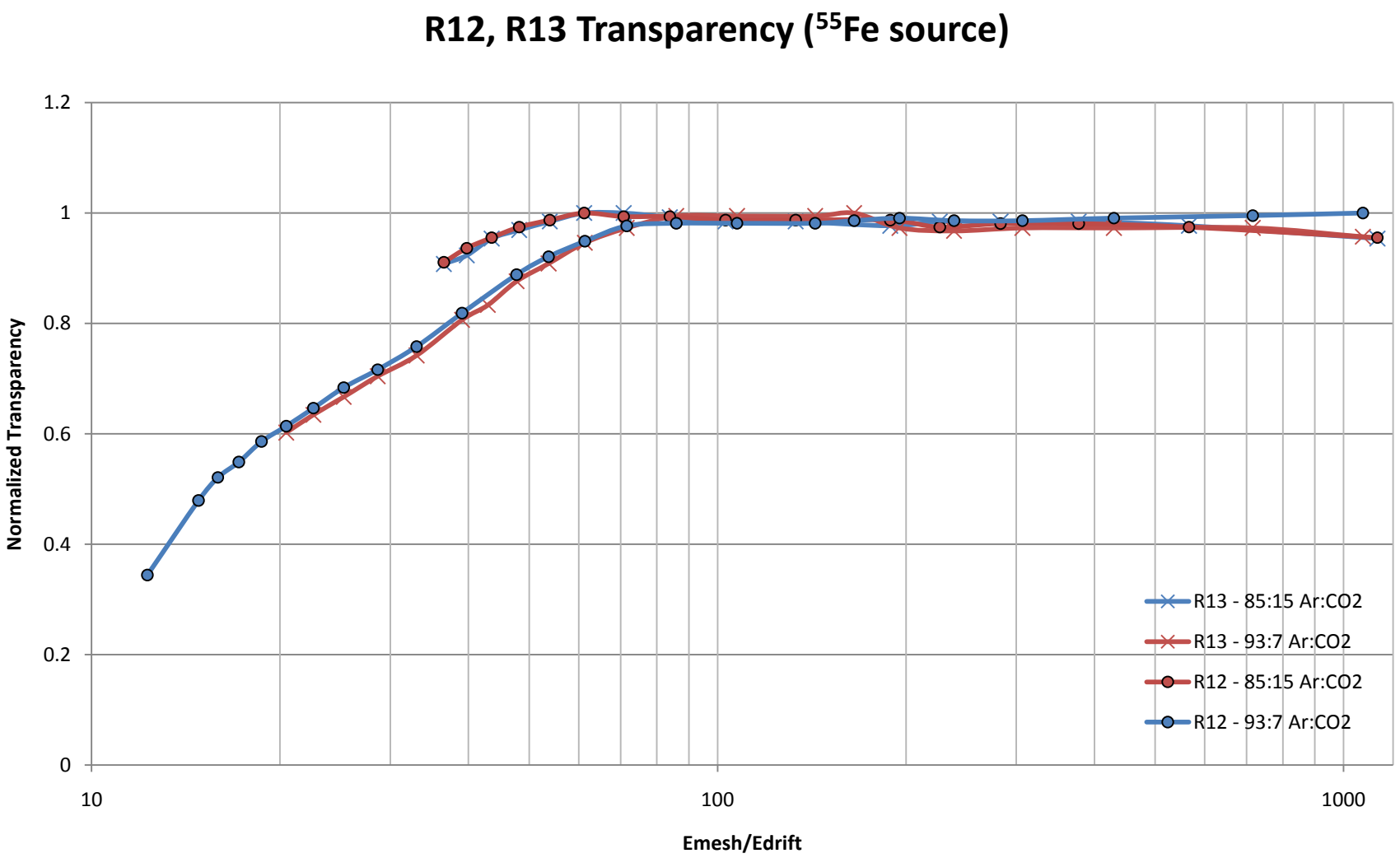
Laboratory tests (2)



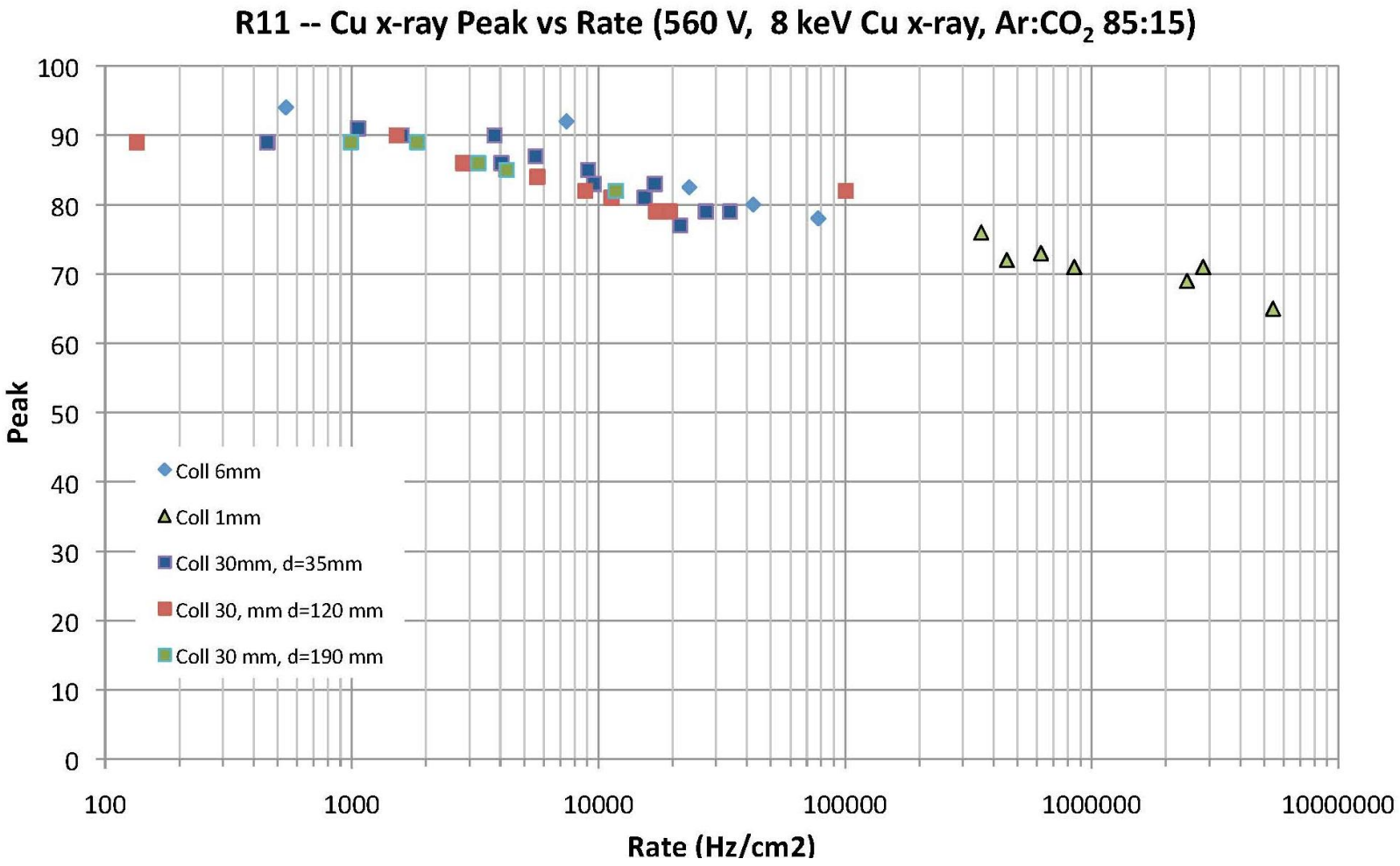
Laboratory tests (3)



Laboratory tests (4)

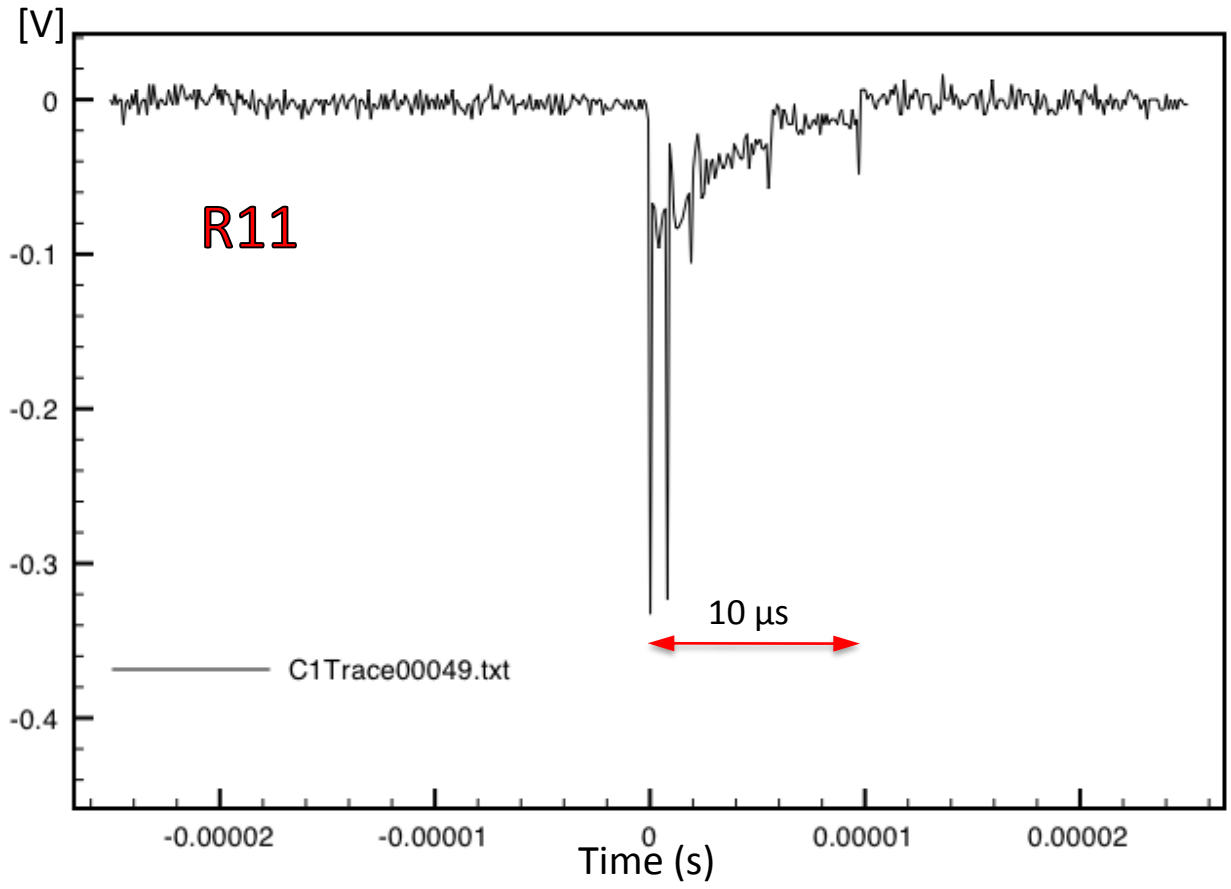


Laboratory tests (5)



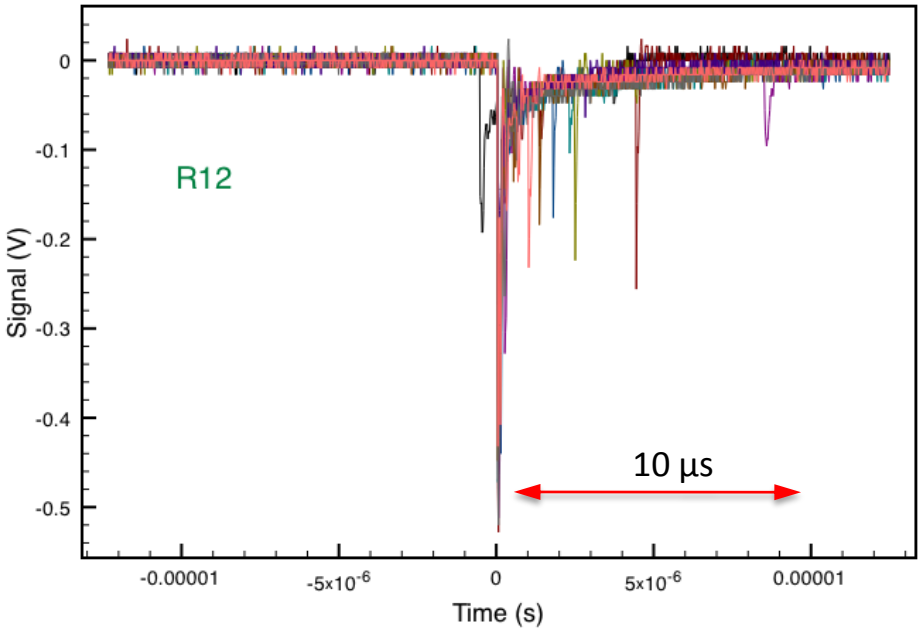
Laboratory tests (6)

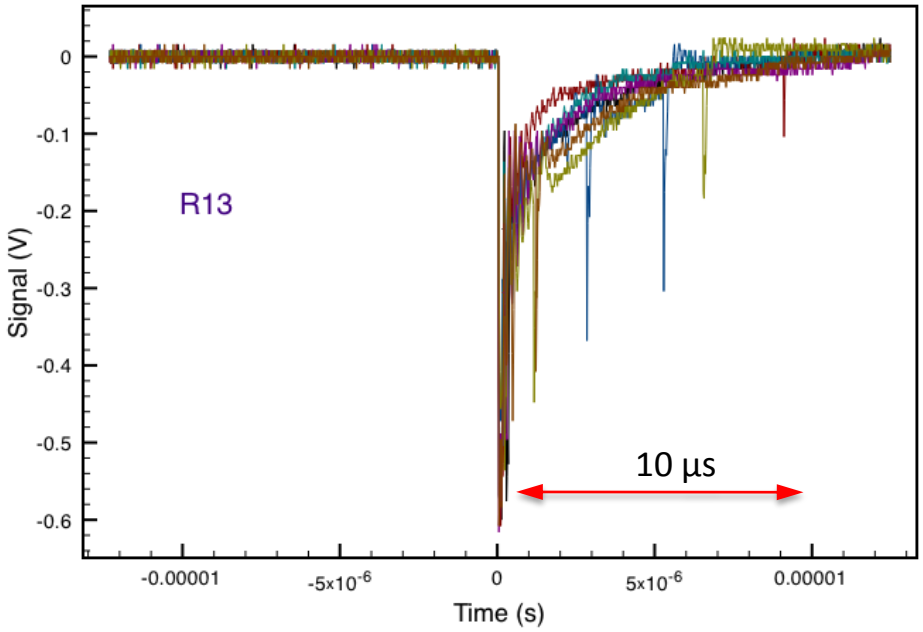
Spark shape & characteristics – R11



Laboratory tests (7)

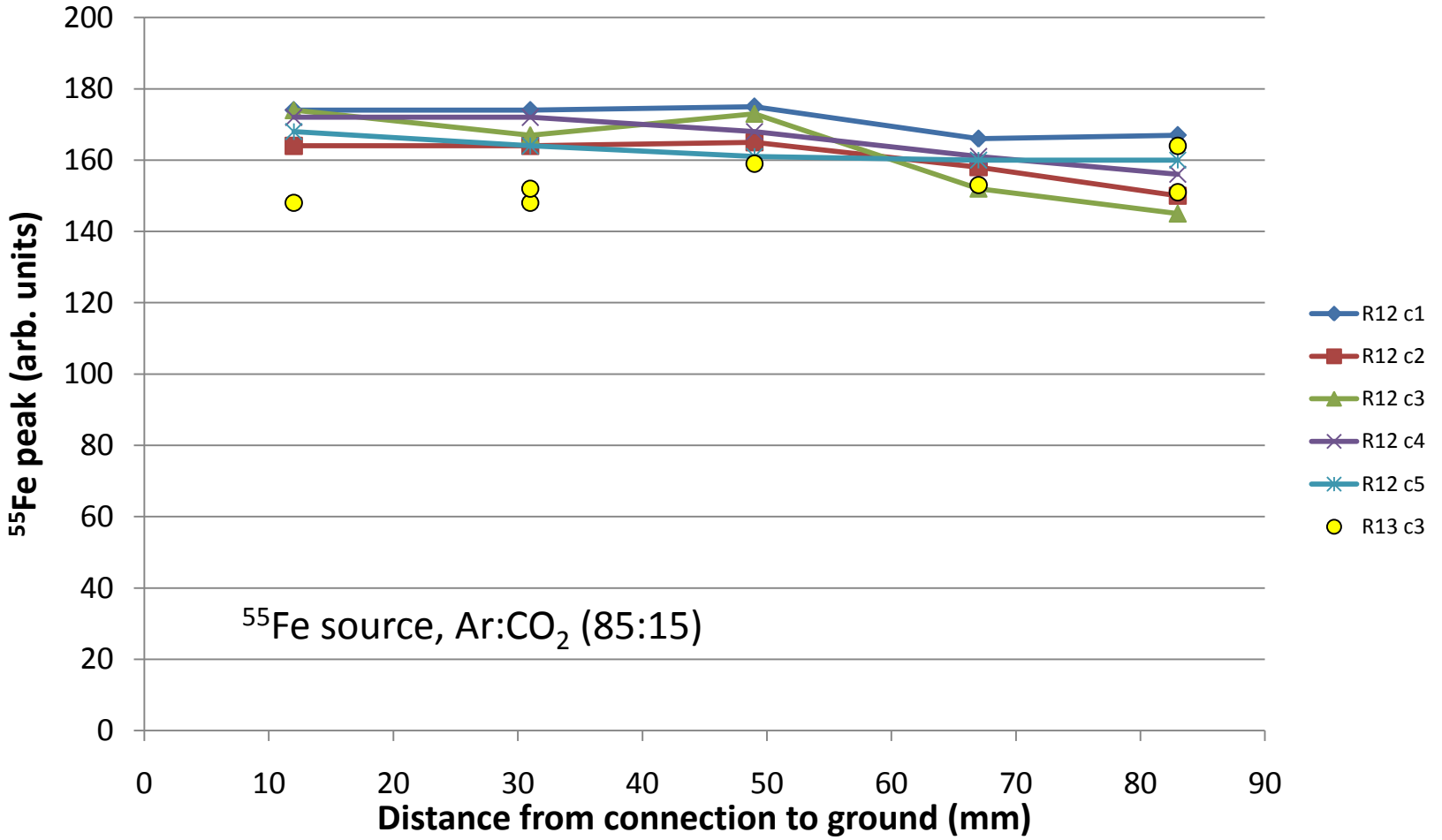
Spark shape & characteristics – R12 & R13





Laboratory tests (8)

Homogeneity of chambers



Conclusions from the laboratory tests

- R11, R12 and R13 are working fine with the ^{55}Fe source and with X-ray gun.
- Very good homogeneity along the strips
- Low spark rate
- Spark current is the order of 10-20 nA, almost 1000 times less than for S3 chamber (non-resistive)
- No HV breakdown, no dead time

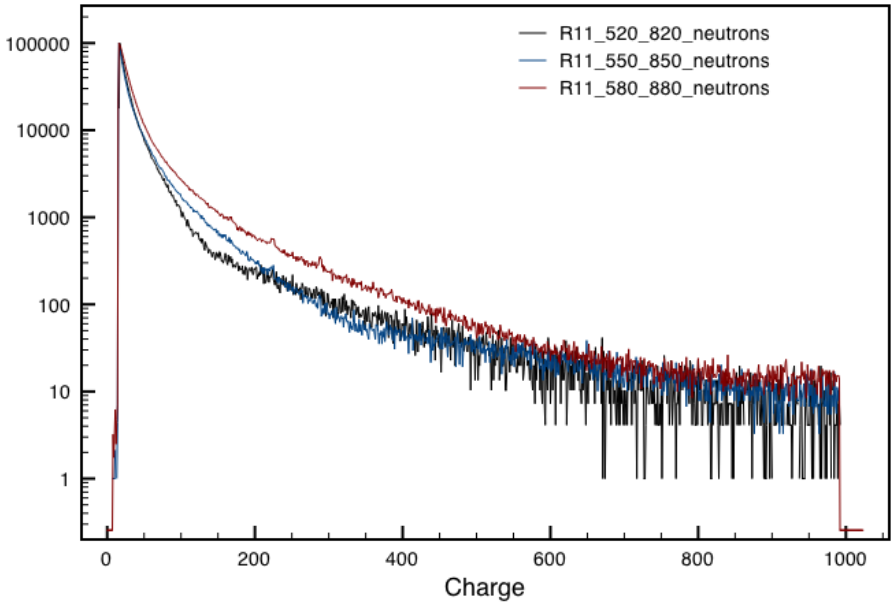
Neutron beam test at Demokritos National Research Center

- Exposed R11 and a standard MM in first week of May to neutron beam at Demokritos NRC (Athens)
- Neutrons of 5.5 MeV with fluxes up to 1.5 x 10^6 n/cm^2
- R11 & sMM were read out through
  - Single preamplifier (OR of 72 or all 360 strips)
  - Single preamplifier (mesh current)
  - 64 individual strips connected to Gassiplex readout system (under analysis, not reported here)
- Gas mixtures tested: Ar:CO_2 (85:20; 85:15, 93:7)

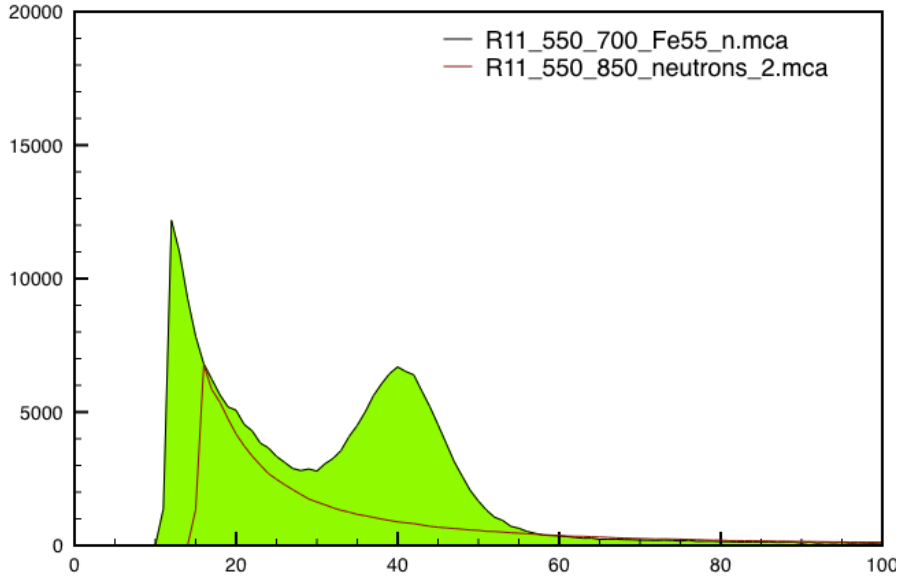
Neutron beam test (1)

Neutron spectra in R11

Typical charge spectra recorded in neutron beam



^{55}Fe spectrum taken under neutron irradiation



Gas: Ar:CO_2 (85:15)

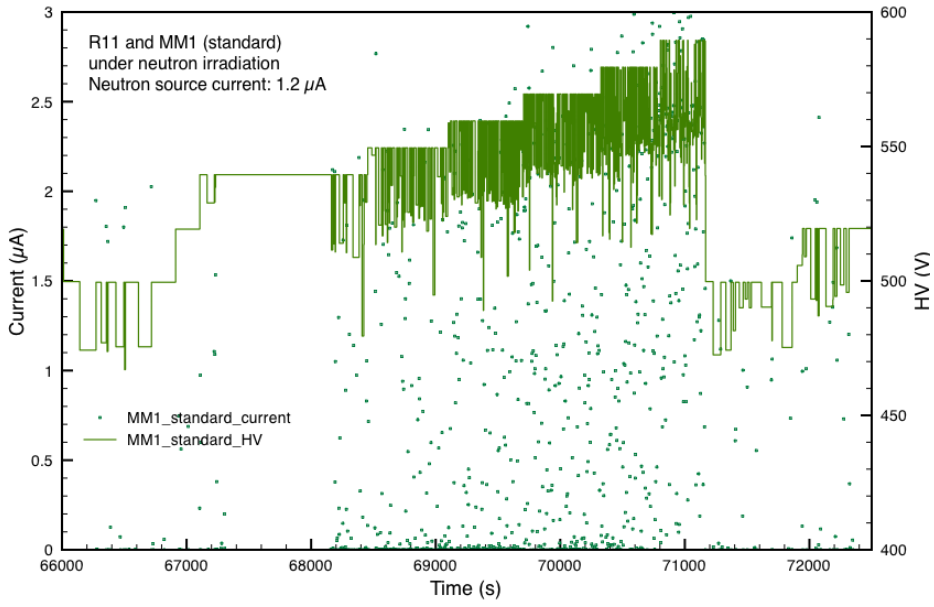
Neutron beam test (2)

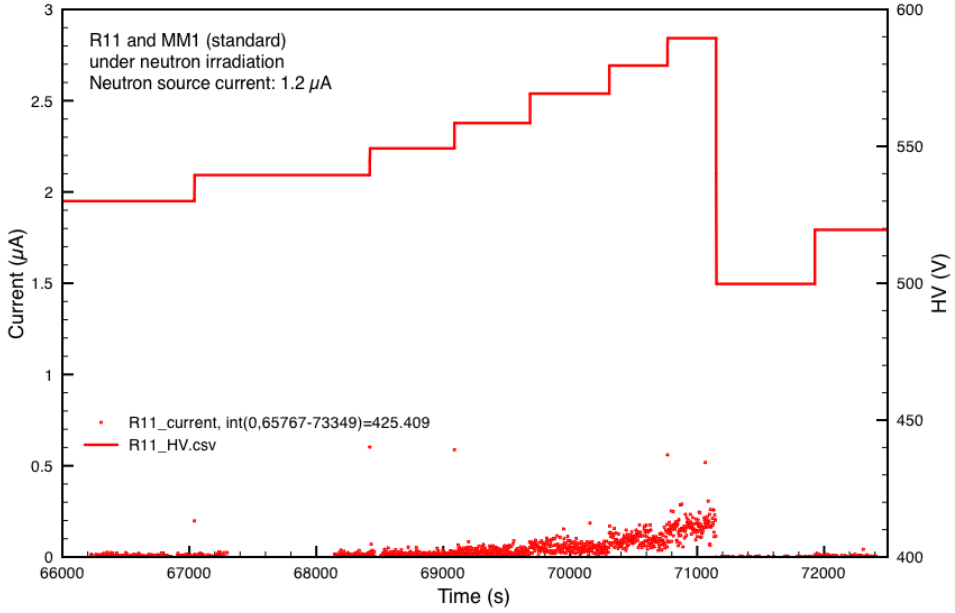
MM mesh currents in neutron beam

Gas: Ar:CO_2 (85:15) Neutron flux: ≈ 10^6 n/cm^2

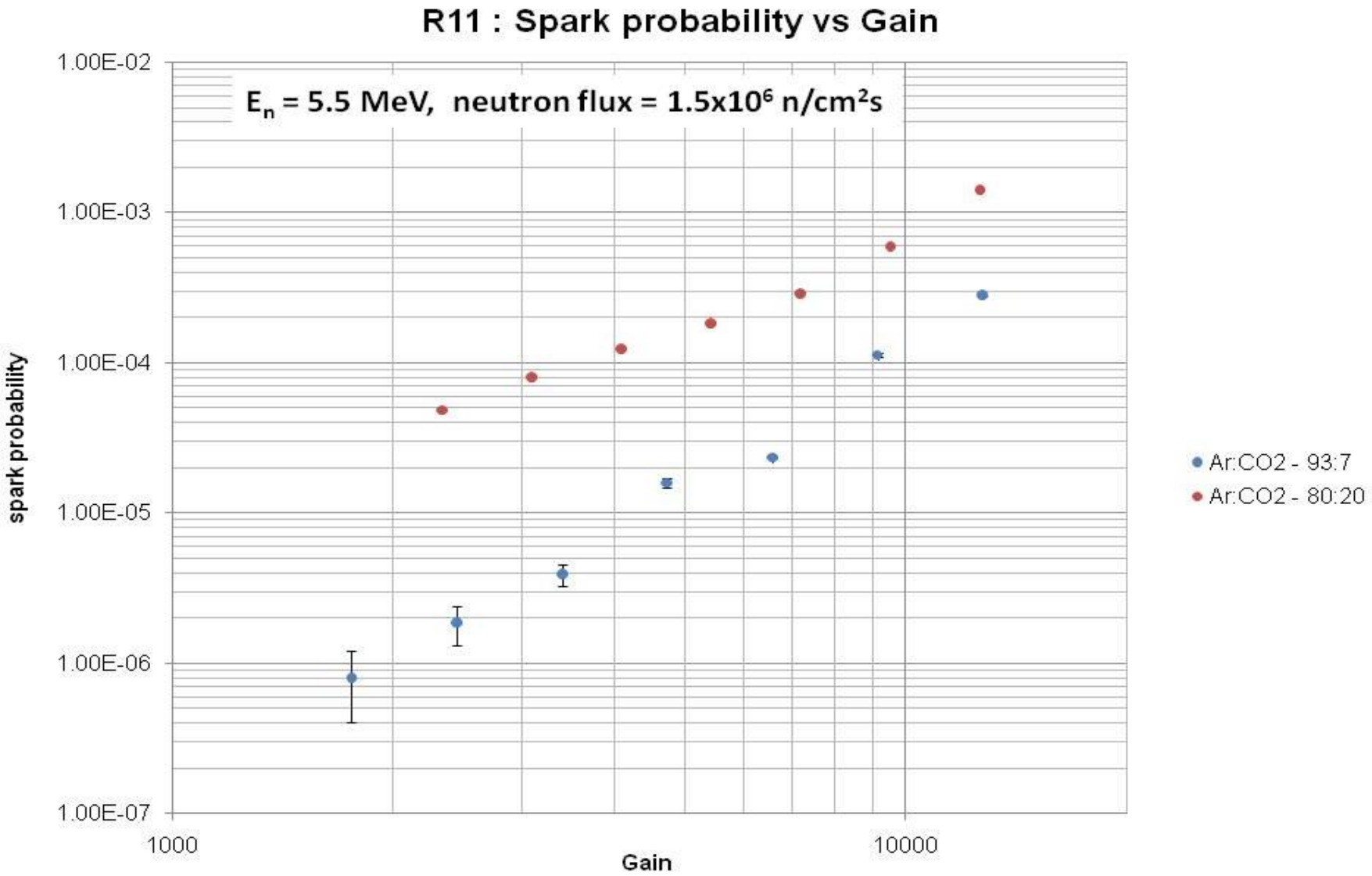
Standard MM:
Large currents
Large HV drops, recovery time O(1s)
Chamber could not be operated stably

R11:
Low currents
Despite discharges, but no HV drop
Chamber operated stably up to max HV





Neutron beam test (3)



Conclusions from neutron test (R11)

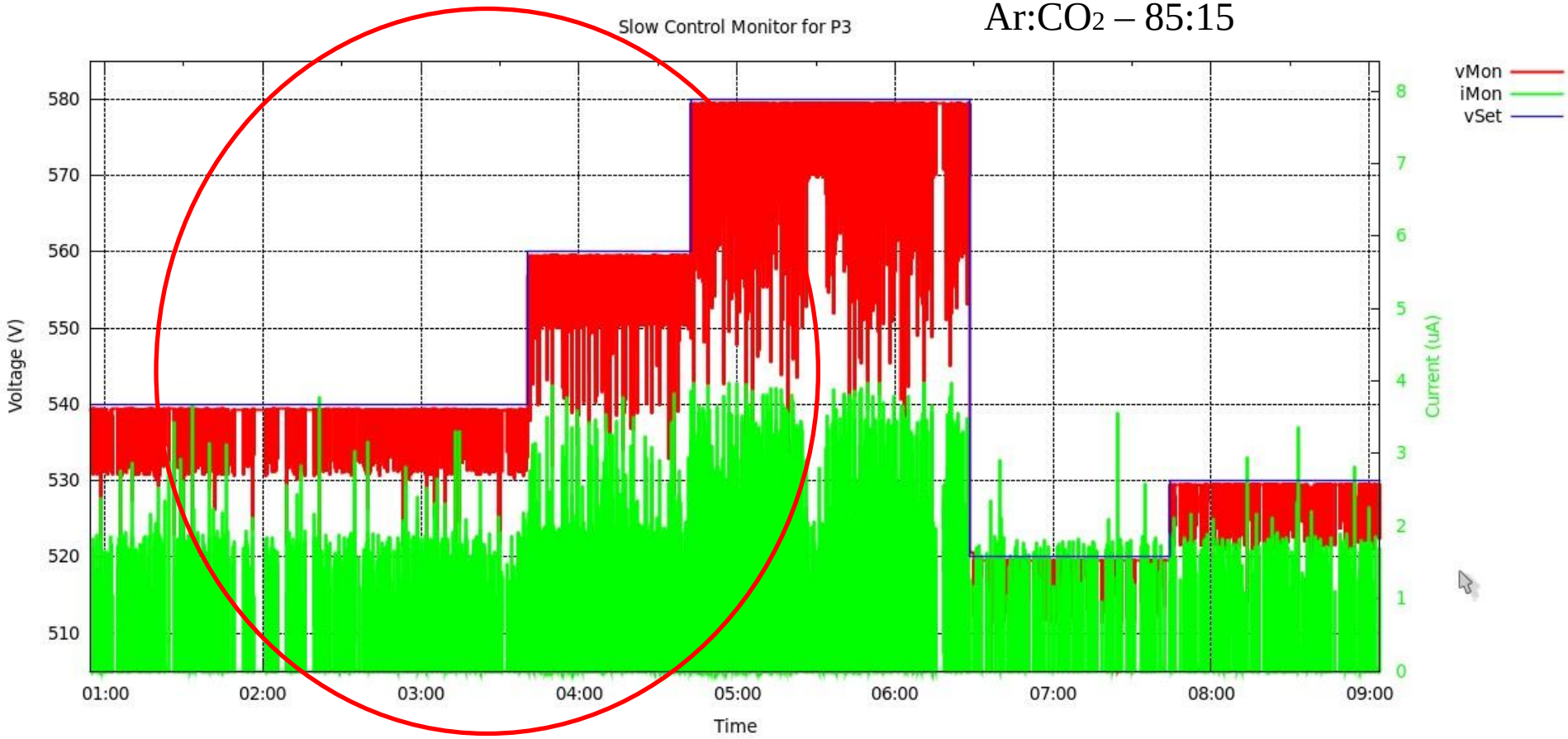
- R11 worked fine in a neutron flux of up to 1.5 x 10^6 n/cm^2
- Despite sparks, no HV breakdown, no dead time
- Clear signal from a ^{55}Fe source under neutron irradiation
- Measured three Ar:CO_2 gas mixtures, 93:7 looks very interesting, with a spark rate almost a factor 10 lower than for 80:20

Beam test in H6
5-18 July 2010

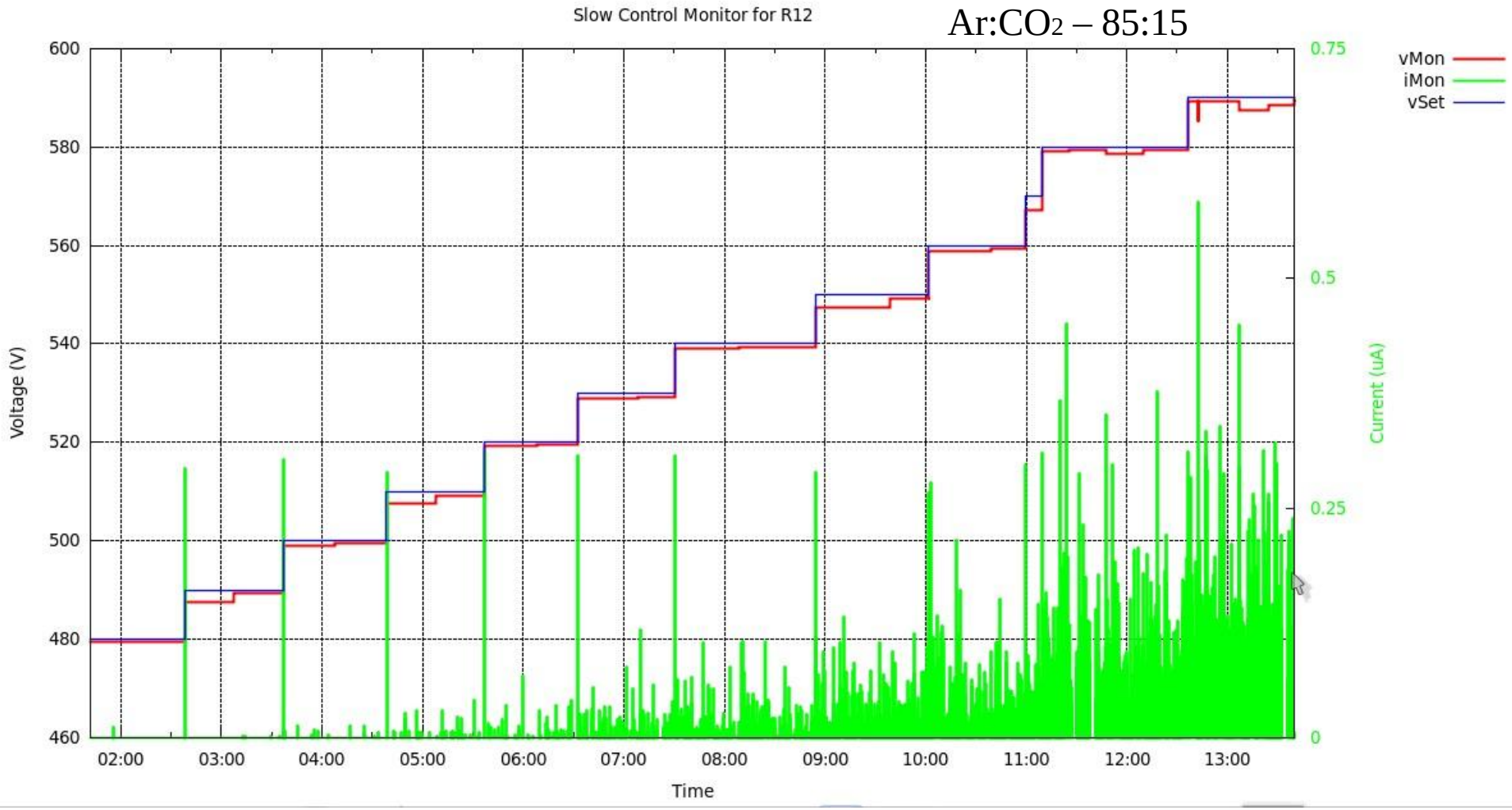
- R11, R12, R13, and P3 chambers were tested in +120 GeV pion beam (intensities 40 kHz & 5 kHz) for two Ar:CO_2 mixtures, 85:15 and 93:7
- Main goals:
  - Study HV and current behaviour of resistive and non-resistive chambers in a hadron beam
  - Measure performance (spatial resolution and efficiency) of resistive chambers
  - Study performance of long strips (0.4 m & 1m, non-resistive)
- A few million of events to be analyzed

Beam test in H6 (1)

Ar:CO_2 – 85:15

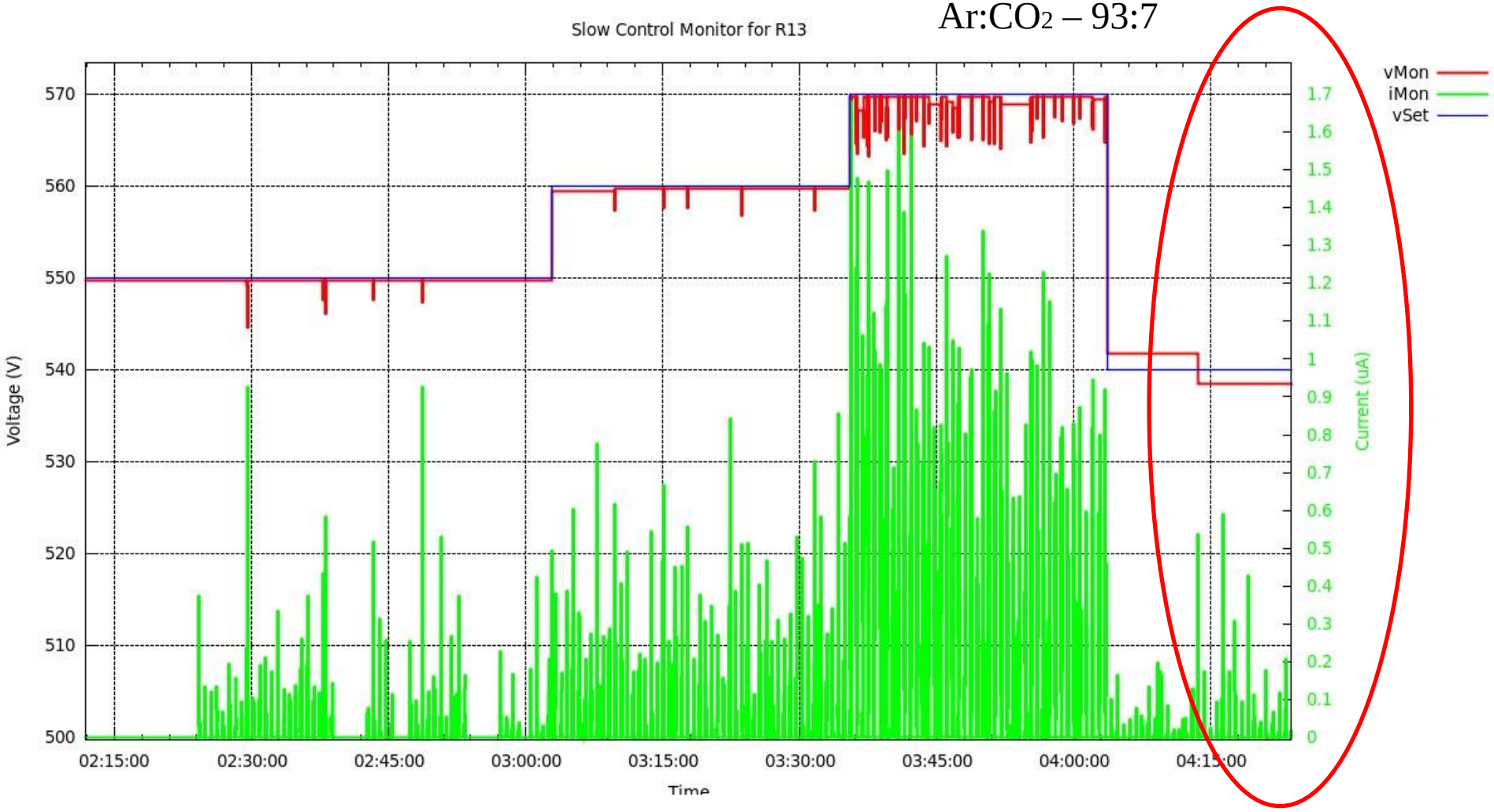


Beam test in H6 (2)

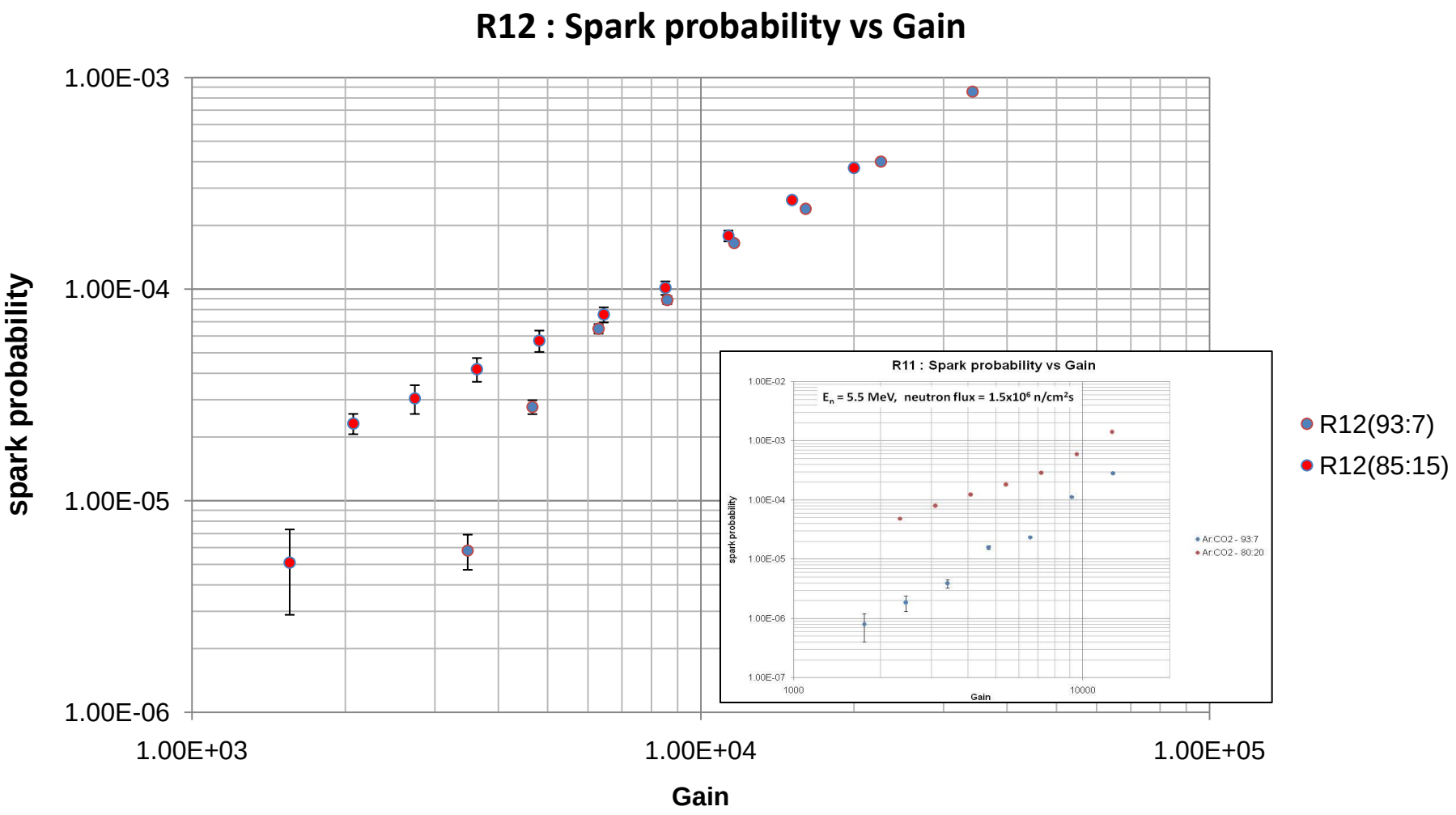


Beam test in H6 (3)

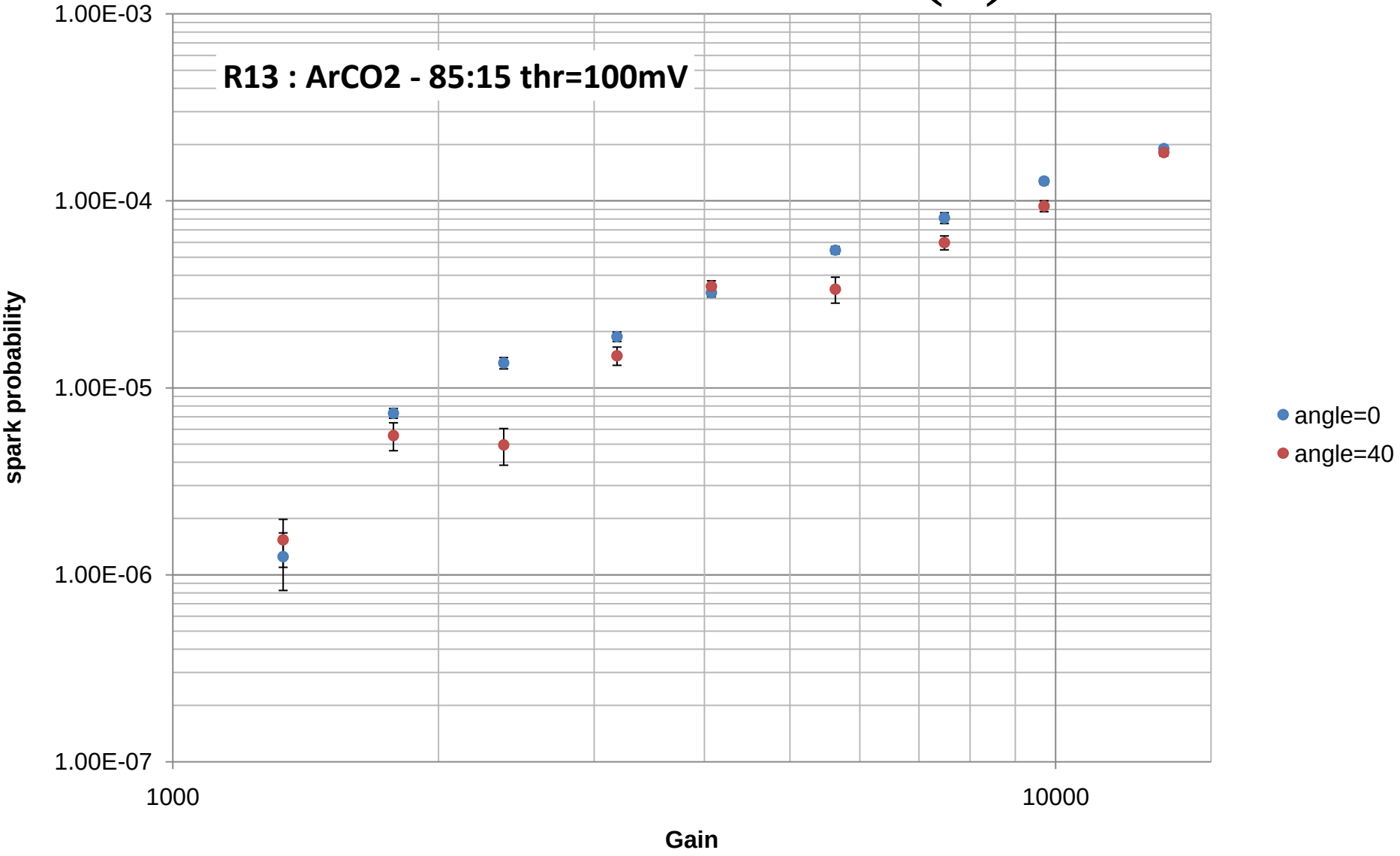
Ar:CO_2 – 93:7



Beam test in H6 (4)



Beam test in H6 (5)



Overall conclusions

- R11, R12 and R13 show very similar behavior
- Robust & stable, no breakdown at all, excellent performance in neutron and hadron beams
- Signals are clean, good gas gain and energy resolution (slightly better for R12)
- Charge-up reduces signal by less than 10%
- Homogeneity across chamber good
- Short and small spark signals and fast recovery time
- Ar:CO_2 mixture 93:7 gives a factor 10 lower spark rate under neutron irradiation compared to 80:20 (no difference in hadron beam with 85:15)